

Preliminary Amendment

Applicant: Edward Fuer gut et al.

Serial No.: Unknown

(Priority Application No. DE 103 28 265.3)
(International Application No. PCT/DE2004/001147)

Filed: Herewith

(Priority Date 23 June 2003)
(International Filing Date 04 June 2004)

Docket No. I431.139.101/FIN 474 PCT/US

Title: SENSOR COMPONENT AND PANEL USED FOR THE PRODUCTION THEREOF

REMARKS

This Preliminary Amendment amends the above identified Utility Patent Application filed herewith. With this Preliminary Amendment, claims 1-13 have been cancelled. New claims 14-33 have been added. Claims 14-33 remain pending in the application and are presented for consideration and allowance.

A substitute specification is included herewith. The specification contains no new matter.

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CONCLUSION

No fees are required under 37 C.F.R. 1.16(b)(c). However, if such fees are required, the Patent Office is hereby authorized to charge Deposit Account No. 500471.

Any inquiry regarding this Preliminary Amendment should be directed to Steven E. Dicke at the below-listed telephone numbers.

The Examiner is invited to contact the Applicants' representative at the below-listed telephone number to facilitate prosecution of this application.

Respectfully submitted,

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Date of Deposit: December 22, 2005

I hereby certify that this is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is addressed to: Mail Stop PCT, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313.1450.

By Vanessa Carels
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Description

IAP20 REG'D PCT/PTO 22 DEC 2005

**SENSOR COMPONENT AND PANEL USED FOR THE PRODUCTION
THEREOF**

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Field of the Invention

_____ The invention relates to a sensor component and a panel with a plurality of sensor component positions, sensor chips with sensor regions and with contact areas on their active top sides being arranged in the positions.

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Background

_____ The sensor chips of sensor components ~~of this type~~ have hitherto been arranged on a circuit substrate or on a panel in the form of a printed circuit board with a plurality of sensor component positions. An arrangement of this type necessitates producing, toward the circuit substrate or toward the panel, in each of the sensor component positions, connections from the contact areas to contact pads on the circuit substrate. These connections are created by means of time-consuming and cost-intensive, and also thermally stressing connection techniques, which restricts the reliability of the sensor component and at the same time causes high costs.

Summary

_____ ~~It is an object of the invention to provide~~ The present invention provides a sensor component which has an improved reliability and can be produced more cost-effectively.

_____ ~~This object is achieved by means of the subject matter of the independent claims. Advantageous developments of the invention emerge from the dependent claims.~~

In one embodiment, The invention specifies provides a sensor component having

a sensor chip with a sensor region on its active top side. The electrodes of the sensor region are connected via conductor tracks to contact areas on the active top side of the sensor chip. The sensor chip is embedded in a plastic plate by its rear side and by its edge sides, the active top side of the sensor chip together with a top side of the plastic plate forming an overall top side. A rewiring structure with a rewiring layer is arranged on ~~said~~the overall top side, the rewiring lines extending from the contact areas to external contact areas of the sensor component.

10 A sensor component of this type has the advantage that it is not necessary to overcome level jumps for the electrical connections between sensor chip and plastic plate, rather the rewiring structure with its rewiring lines is arranged on an overall top side. Complex connection techniques, such as bonding technique or flip-chip technique, are consequently obviated. Moreover, with the sensor chip as many semiconductor chips and passive components as desired can be embedded in the plastic plate to form a sensor module. For this purpose, electrode areas of passive components embedded in the plastic plate, are provided in the overall top side. In this case, the rewiring lines on the overall top side connect electrode areas of the passive components to contact areas of the sensor chip and/or of the semiconductor chip and/or of the external contact areas.

15 Such wiring with the aid of rewiring lines is effected within a single rewiring layer. This rewiring layer may be extended by further insulation layers and rewiring layers, a plurality of rewiring layers being connected to one another via through contacts through the insulation layers. This results in a multilayer rewiring structure that is formed without a high outlay on to the overall top side comprising semiconductor top sides and plastic top sides.

20 Instead of an arrangement of sensor chip and semiconductor chip alongside one another, it is also possible to accommodate a stacking of a sensor chip with a semiconductor chip one above the other in the plastic plate. This has the advantage that the overall top side of the sensor component can be kept

small.

_____ The sensor region may react to pressure, temperature, thermal radiation or electromagnetic radiation.

5

_____ In a further embodiment of the invention, a lens is arranged above the sensor region in order to achieve a higher optical sensitivity. Said ~~The~~ lens may be composed of glass or have a flat lens film with Fresnel rings, which has the advantage that the height of the sensor component is not significantly increased 10 by fitting a Fresnel lens.

_____ Outside the region of the sensor chip, in a further embodiment of the invention, the plastics composition may have through contacts to external contact areas which are situated opposite to the overall top side. This has the 15 advantage that the sensor region is freely accessible, even if the sensor component is fixed on a printed circuit board with the aid of the external contacts. Otherwise, that is to say if no through contacts are provided through the plastics composition, and the external contacts are arranged on the same top side, that is to say on the common overall top side, it would be necessary to provide 20 an opening in a printed circuit board arranged thereabove, thereby enabling access to the sensor region of the sensor chip. The through contacts to the external contact areas can be electrically connected via rewiring lines to the contact areas of the sensor chip on the overall top side.

25

_____ A further aspect of the invention relates to an optoelectronic device, which has a sensor component accommodated in a camera housing. In this case, the sensor region of the semiconductor chip has a CCD structure or some other image recording structure by means of which, by way of example, images can be recorded by means of a mobile phone and can be transmitted to a call partner.

30

_____ The sensor component may also have an addition, such that it can be used as an optoelectronic coupling component. In this case, an optical fiber plug-

in region, in which an optical fiber as optical waveguide can be plugged in, is arranged above the sensor region. Optoelectronic coupling components of this type are required in large quantities, so that the cost-effective production of the sensor component according to the invention is advantageous.

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_____ A further aspect of the invention relates to a panel having component positions arranged in rows and columns for sensor components. In this case, the panel already has all the circuit components of the sensor component, such as sensor chip with sensor region and with contact areas, top sides of semiconductor chips with contact areas, electrodes of passive strip elements, a plastic top side surrounding the semiconductor chip top sides, a rewiring structure on an overall top side. In this case, the rewiring structure has a rewiring layer with rewiring lines which connects the contact areas of the sensor chips to external contact areas of the sensor component. On the overall top side of the panel, external contacts may also be arranged on the external contact areas in order to complete a sensor component in each of the component positions before the panel is separated into individual components.

20

_____ In one embodiment, Aa method for the production of a panel has includes
the following: ~~method steps~~.

25

_____ Firstly, provision is made of a semiconductor wafer having sensor chip positions arranged in rows and columns. Afterward, the semiconductor wafer is separated into individual sensor chips with a sensor region and contact areas on an active top side of the sensor chips. An adhesive film or an adhesive plate is then inserted into a first mold half with component positions arranged in rows and columns. There is then applied to the component positions of the adhesive film or of the adhesive plate in each case a sensor chip of the semiconductor wafer in the component positions with adhesive bonding of the active top side of the sensor chips on to the adhesive side of the adhesive film or the adhesive plate.

30

_____ The mold halves are then brought together and a plastics composition is

5 injected into the mold with the sensor chips being embedded on one side. After the plastics composition has been cured to form a composite plate comprising plastics composition and sensor chips, the mold halves are moved apart and the composite plate is removed. Finally, the adhesive film or the adhesive plate is removed from the composite plate and a rewiring structure is applied to the freed overall top side of the composite plate.

10 _____ This method has the advantage that after the injection-molding of the composite plate, a common overall top side for the application of further coatings is available simultaneously for a plurality of sensor components. Furthermore, the method has the advantage that neither a step between the active top side of the sensor chip and the plastics composition nor a distance between the active top side of the sensor chip and the plastics composition occurs, so that the entire sensor component can be wired with a single rewiring layer. This 15 rewiring layer of the rewiring structure has rewiring lines that connect the contact areas of the sensor chip to external contact areas of the sensor component. Furthermore, external contacts in the form of solder bumps or solder balls or external contact pads can be applied to said external contact areas whilst still in the state of the panel.

20 _____ In a further exemplary implementation of the method, electrodes of passive components are concomitantly applied to the adhesive film or adhesive plate, so that it is possible to realize a more complex sensor circuit for the sensor component. Furthermore it is also possible to position additional semiconductor 25 chips with integrated circuits in the component positions, to be precise in each case with their contact areas on the adhesive film or adhesive plate, in order that when the adhesive film or adhesive plate is stripped away, the contact areas of the additionally integrated circuits can be contact-connected by rewiring lines.

30 _____ Consequently, this method makes it possible to construct complex sensor components in an extremely simple manner, only one molding step being required for creating the card-type housing and only one patterned rewiring layer

being required for the connection of the individual circuit components in the form of passive components and integrated circuit elements and sensor chips. If the sensor chip and a semiconductor chip with integrated circuit should be stacked one above the other, then it is necessary to carry out an internal stack

5 wiring prior to embedding in the common plastic plate and/or an elevation of the contact areas of the lower semiconductor chip is required in order to wire them on the overall top side with other components of the sensor component.

10 A method for the production of a sensor component has the additional method step that after the production of a panel, external contacts are also applied to the external contact areas and the panel is subsequently separated into individual sensor components.

15 To summarize, it can be stated that the invention produces an inexpensive, space-saving housing which additionally has a good characteristic with regard to moisture sensitivity. This is achieved by virtue of the fact that the housing is constructed on the basis of a so-called “universal package” technology. Unlike in the mounting of normal, non-optical semiconductors, in the case of the optoelectronic components, the sensor areas are not covered by

20 dielectrics or soldering resists, but rather are left free for later covering with optical materials or optical components, for example lenses. To summarize, the following advantages are thus afforded:

25 1. low production costs of the housing;
2. small space requirement of the housing as is required for mobile phone cameras, for example;
3. a surface mounting of the housing is possible on account of the low moisture sensitivity, which means that the component according to the invention can be soldered on to a circuit board of a higher-level circuit in

30 normal surface-mounting processes without any problems.

Brief Description of the Drawings

~~The invention will now be explained in more detail with reference to the accompanying figures.~~

The accompanying drawings are included to provide a further understanding of the present invention and are incorporated in and constitute a part of this specification. The drawings illustrate the embodiments of the present invention and together with the description serve to explain the principles of the invention. Other embodiments of the present invention and many of the intended advantages of the present invention will be readily appreciated as they become better understood by reference to the following detailed description.

10 The elements of the drawings are not necessarily to scale relative to each other.
Like reference numerals designate corresponding similar parts.

15 Figure 1—shows illustrates a schematic perspective view of a sensor component

-of-a-first embodiment of the invention,

Figure 2—shows illustrates a schematic cross section through a sensor component

-in a housing in accordance with a second embodiment of the invention,

20

Figure 3—shows illustrates a schematic cross section through a sensor component

-as coupling component in accordance with a third embodiment of the invention,

25

Figure 4—shows illustrates a schematic cross section through a sensor component

-position of a panel prior to the application of external contacts,

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Figure 5—shows illustrates a schematic cross section through a sensor component

-after application of a lens to a sensor region of the component as fourth embodiment of the invention,

_____ **Figure 6** showsillustrates a schematic cross section through a
sensor component

-in accordance with a fifth embodiment of the invention.

5

_____ **Figure 7** showsillustrates a schematic cross section through a
sensor component

-in accordance with a sixth embodiment of the invention,

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_____ **Figure 8** showsillustrates a schematic cross section through a
sensor component

-in accordance with a seventh embodiment of the invention.

Detailed Description

15

_____ Figure-1 showsillustrates a schematic perspective view of a sensor
component 1 of a first embodiment of the invention. A sensor chip 2 is
embedded by its edge sides 36, 37, 38 and 39 in a plastic plate 6 with the edge
sides 8, 9, 11 and 12. An active top side 5 of the sensor chip 2 and a top side 35
of the plastic plate 6 form an overall top side 13. In addition to the active top
side 5 of the sensor chip 2, the overall top side 13 comprises an active top side of
an additional semiconductor chip 21, on which contact areas 29 are arranged.
Furthermore, the electrode areas 18 of three passive components 19 are arranged
on the overall top side 13.

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_____ Besides the contact areas 4 and 29 or of the both of the sensor chip 2 and
of the semiconductor chip 21 and of the electrodes 18 of the passive components
19, the overall top side has external contact areas 17 on which external contacts
25 are arranged.

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_____ A rewiring layer 15 is arranged on the overall top side 13, which rewiring
layer, with its rewiring lines 16, connects contact areas 4 of the semiconductor
chip 2 to contact areas 29 of the semiconductor chip 21 and connects contact

areas 4 to electrode areas 18, and, via further rewiring lines 16, connects the contact areas 4 and 29 and also the electrode areas 18 to external contact areas 17 on the overall top side 13. Consequently, the sensor component 1 shown in figure 1 already constitutes a sensor module and can be connected via the 5 external contacts 25 to a higher-level circuit on a printed circuit board. In the case of such surface mounting of a sensor component of the first embodiment of the invention, as shown in figure 1, it is necessary to provide an opening in the higher-level circuit board, said opening corresponding to the sensor region 3 of the sensor chip 2, in order to enable access on the sensor region 3.

10 Figure 2 ~~shows~~illustrates a schematic cross section through a sensor component 10 in a camera housing 26 in accordance with a second embodiment of the invention. Components having functions identical to those in figure 1 are identified by the same reference symbols and are not discussed separately.

15 The sensor component 10 is a part of a camera component 41, and is arranged on a higher-level circuit board 42 in the camera housing 26 of a mobile telephone. The three components, system component 10, circuit board 42 and camera housing 26, are arranged one above another, the sensor component 10 20 being arranged below the higher-level circuit board 42 and the circuit board 42 being arranged below the camera housing 26. The sensor component 10 has a sensor chip 2, a semiconductor chip 21 and passive components 19. The sensor chip 2 has an active top side 5 with a sensor region 3 and contact areas 4 and a rear side 7. The semiconductor chip 21 has contact areas 29, and the passive 25 component 19 has electrode areas 18.

30 The sensor chip 2, the semiconductor chip 21 and the passive components 19 are embedded in a plastic composition 31 in such a way that they form a plastic plate 6 having an overall top side 13 with the sensor region 3, the contact areas 4 and 29 and the electrode areas 18. Rewiring lines 16 which interconnect the circuit elements 2, 19 and 21 and produce electrical connections to external contact areas 17 are arranged on said overall top side 13. External

contacts 25 which are soldered to the higher-level circuit board 42 are arranged on the external contact areas 17.

5 The rewiring lines 16 form a rewiring layer 15, which is part of a rewiring structure 14, the rewiring structure 14 additionally having an insulating covering layer 45, which leaves only the sensor region 3 and the external contact areas 17. The sensor region 3 bears a lens 22 oriented with respect to the optical axis 47 of a second lens 34, the second lens 34 being oriented between camera housing 26 and higher-level circuit board 42.

10 The higher-level circuit board 42 and the camera housing 26 have openings 43 and 44, the side of which corresponds to the sensor region 3 of the sensor chip 2, so that the optical impression of the surroundings can act on the sensor region 3 of the sensor chip 2 via the lenses 34 and 22. A sealing element 15 46 between the second lens 34 and the camera housing 26 ensures that no moisture and no dust particles can penetrate into the housing 26.

20 Figure 3 ~~shows~~ illustrates a schematic cross section through a sensor component 20, designed as a coupling component in accordance with a third embodiment of the invention. Components having functions identical to those in the previous figures are identified by the same reference symbols and are not discussed separately.

25 The sensor component 20 has a similar construction to the sensor component 10 in figure 2, but the lens 22 is oriented to an optical fiber 51. Instead of the camera housing 26 as in figure 2, an optical fiber plug-in region 27 with an optical fiber plug-in base 48 is arranged above the opening 44 in the higher-level circuit board 42 and fixed on the higher-level circuit board 42. The 30 optical fiber plug-in base 48 is structured in such a way that a plug-in sleeve 49 which is fixed on the optical fiber 51 can be brought into engagement with the optical fiber plug-in base 48. The optical fiber plug-in base 48 is oriented in such

a way that the optical axes 47 of the optical fiber 51 and the lens 22 are oriented with respect to one another.

5 Figure 4 ~~shows~~ illustrates a schematic cross section through a sensor component position 33 of a panel 28 prior to the application of external contacts and prior to the separation of the panel 28 into individual sensor components. Components having functions identical to those in the previous figures are identified by the same reference symbols and are not discussed separately.

10 The panel 28 has a composite plate 32 with a plastic plate rear side 24. The composite plate 32 comprises a plastics composition 31 and sensor chips 2, semiconductor chips 21 and passive components 19 embedded therein. The circuit components 2, 19 and 21 are embedded in the plastics composition 31 of the composite plate 32 in such a way that they form an overall top side 13 which 15 is covered with a rewiring structure 14 comprising a rewiring layer 15 with rewiring lines 16. An insulating covering 45 then leaves free only the sensor regions 3 and the external contact areas 17 in each of the component positions 33 of the panel 28.

20 Figure 5 ~~shows~~ illustrates a schematic cross section through a sensor component 30 after application of a lens 22 to a sensor region 3 of the sensor component 30 according to a fourth embodiment of the invention. The lens 22 and the external contacts 25 for each of the sensor components 30 may either already be applied to the panel shown in figure 4 in each of the component 25 positions or be subsequently fixed on each individual sensor component 30. The fourth embodiment of the invention as shown in figure 5 exclusively has external contacts 25 on external contact areas 17 which are connected via rewiring lines 16 to corresponding electrodes of the embedded circuit components of the sensor component 30.

30 Figure 6 ~~shows~~ illustrates a schematic cross section through a sensor component 40 of a fifth embodiment of the invention. Components having

functions identical to those in the previous figures are identified by the same reference symbols and are not discussed separately.

5 The fifth embodiment of the invention in accordance with figure 6 differs from the fourth embodiment in accordance with figure 5 by virtue of the fact that in addition to external contacts 25 which are connected via rewiring lines 16 to the electrode areas 19 and contact areas 4 and 29 of the circuit components 2, 18 and 21 of the sensor component, distance-maintaining external contacts 52 are arranged on the overall top side. The external contacts 52 ensure, in the course of 10 soldering the sensor component 40 on to a higher-level circuit board, that a sufficient distance between the lens 22 and the circuit board arranged thereabove is complied with. In the fifth embodiment of the invention, too, the circuit components such as sensor chip 2, semiconductor chip 21 and passive components 19 are arranged in such a way that each of the components can be 15 contact-connected by its electrodes from the overall top side 13.

20 Figure 7 ~~shows~~illustrates a schematic cross section through a sensor component 50 of a sixth embodiment of the invention. This sixth embodiment of the invention differs from the previous embodiments by virtue of the fact that the semiconductor chip 21 and the sensor chip 2 are stacked one on top of the other prior to embedding in the plastics composition 31. In the course of stacking, care is taken to ensure that the contact areas 29 are not covered by the sensor chip 2, rather that the contact areas 29 can be occupied by thermocompression heads 53, the height of which corresponds to the thickness of the sensor chip 2. 25 Consequently, the semiconductor chip 21 arranged below the sensor chip 2 can also be connected to the remaining components of the sensor component 50 via the overall top side 13 and the rewiring layer 15 arranged there.

30 Figure 8 ~~shows~~illustrates a schematic cross section through a sensor component 60 in accordance with a seventh embodiment of the invention. The seventh embodiment of the invention in accordance with figure 8 differs from the previous embodiments by virtue of the fact that through contacts 23 are

provided through the plastics composition 31, the length of said through contacts corresponding to the thickness of the plastic plate 6. It is thus possible to fit external contacts 25 on the rear side 54 of the sensor component 60, which external contacts are then arranged in a manner situated opposite to the lens 22 5 or to the sensor region 3 of the sensor chip 2. With this seventh embodiment of the invention it is possible to realize surface mounting on a higher-level circuit board, an opening in the higher-level printed circuit board not being required since the sensor region 3 of the sensor component 60 is freely accessible despite surface mounting on a higher-level circuit board.